Project 1 Report

CS 4371

Group 2:

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February 20, 2018

Introduction

In this project, we learned how to use the security tools, WireShark and NMap. We also learned configuring and setting up networking systems. After familiarizing ourselves with these networking systems we implemented a security policy and created an Access Control Matrix (ACM) to represent the security policy. The group primarily communicated through Slack, an online messaging application, and documented what was done through a collaborative Google Doc. We met primarily on Thursdays after 3:30pm and Fridays from 10am - 3pm. Task 2 was the most significant of the joint efforts by the members, with Sarah, Casey, Nick, and Peter all contributing to the completion of the task. Casey largely handled management of the Cisco firewall, Kaleb and Sarah were largely responsible for implementation and testing of the iptables, Kaleb created the original version of the ACM and was responsible for subsequent edits, and all members contributed to the composition and editing of this final report. Sarah was responsible for the completion of the initial slate-clearing tasks in Task 1.

Task II

Task II was completed by Casey, Sarah, Nick and Peter. Casey and Sarah removed the configuration on Router F via Cisco Control Panel on computer F.1. Nick ran NMap to scan the computers and services on Network F (F.1 and F.2) from server A.F and recorded the results. For task 2.4, Peter executed the experiments specified below to check the default security configuration of the firewall, with all rules removed:

- Ping each computer from each other computer
- Navigate to the web server of each computer from each other computer, internal or external

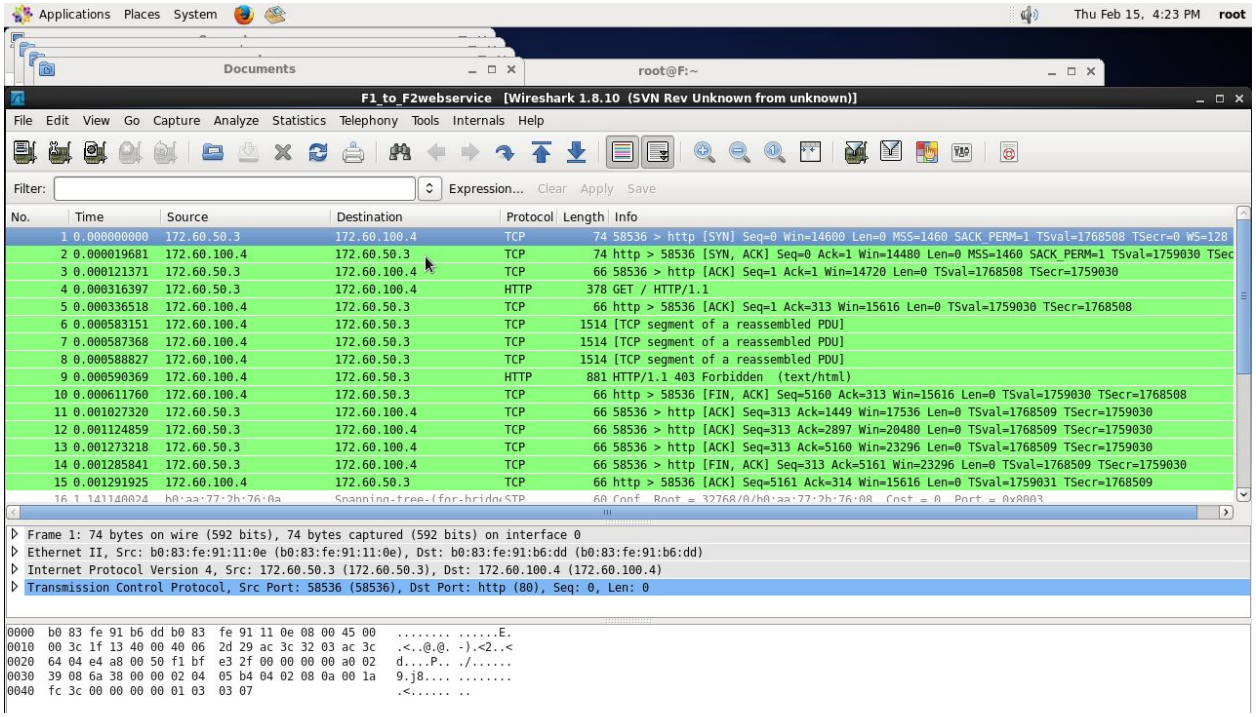
All of the experiments were recorded via Wireshark and the relevant data shown below.

Peter executed the following commands to scan the network F:

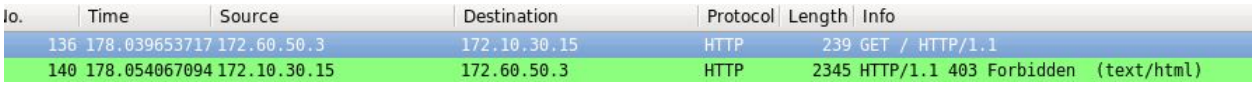
```
$ nmap -sV 172.60.50.3
```

```
$ nmap -sV 172.60.100.4
```

Below are the labeled examples from Peter's experiments.



F.1 to F.2 Webservice

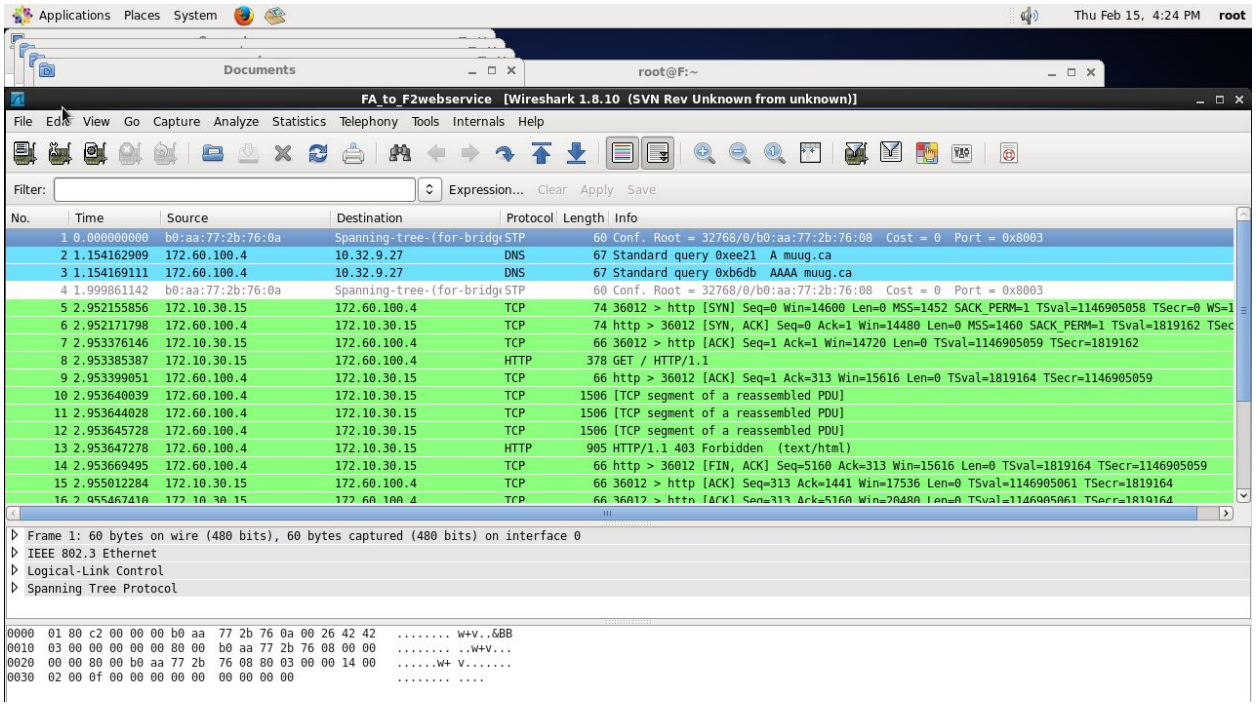


F.1 to A.F web Service

F.2 to A.F Web Service

F.2 to F.1 Web Service

(Note: There is no web server on F.1)



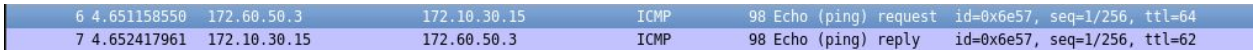
A.F to F.2 Web Service

A.F to F.1 Web Service
(Note: There is no web server on F.1)

As shown in these experiments showing the connectivity between the various computers and the other computer's web servers, the default configuration of the router allows all attempts from a computer to any valid web server through. This is, obviously, not optimal from a security perspective.

Below are shown the pings from each computer to each other computer, including external to internal. Sans security policy, this is permitted, but ultimately undesirable.

F.1 to F.2 Ping



F.1 to A.f Ping

Filter: icmp Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
18	18.830117923	172.60.100.4	172.60.50.3	ICMP	98	Echo (ping) request id=0x6c52, seq=1/256, ttl=64
19	18.830234064	172.60.50.3	172.60.100.4	ICMP	98	Echo (ping) reply id=0x6c52, seq=1/256, ttl=64
20	19.829484797	172.60.100.4	172.60.50.3	ICMP	98	Echo (ping) request id=0x6c52, seq=2/512, ttl=64
21	19.829605205	172.60.50.3	172.60.100.4	ICMP	98	Echo (ping) reply id=0x6c52, seq=2/512, ttl=64
24	20.829469866	172.60.100.4	172.60.50.3	ICMP	98	Echo (ping) request id=0x6c52, seq=3/768, ttl=64
25	20.829590897	172.60.50.3	172.60.100.4	ICMP	98	Echo (ping) reply id=0x6c52, seq=3/768, ttl=64
30	21.829495418	172.60.100.4	172.60.50.3	ICMP	98	Echo (ping) request id=0x6c52, seq=4/1024, ttl=64
31	21.829609249	172.60.50.3	172.60.100.4	ICMP	98	Echo (ping) reply id=0x6c52, seq=4/1024, ttl=64

F.2 to F.1 Ping

Filter: icmp Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
11	14.148822130	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) request id=0x4b52, seq=1/256, ttl=64
12	14.150117667	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) reply id=0x4b52, seq=1/256, ttl=62
13	15.150263957	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) request id=0x4b52, seq=2/512, ttl=64
14	15.151564980	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) reply id=0x4b52, seq=2/512, ttl=62

F.2 to A.F Ping

No.	Time	Source	Destination	Protocol	Length	Info
7	11.115092918	172.10.30.15	172.60.50.3	ICMP	98	Echo (ping) request id=0x3811, seq=1/256, ttl=64
8	11.116389288	172.60.50.3	172.10.30.15	ICMP	98	Echo (ping) reply id=0x3811, seq=1/256, ttl=62

A.F to F.1 Ping

No.	Time	Source	Destination	Protocol	Length	Info
5	3.750678866	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) request id=0x4a11, seq=1/256, ttl=64
6	3.751976186	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) reply id=0x4a11, seq=1/256, ttl=62

A.F to F.2 Ping

It is evident that the default policy on the Cisco Firewall is overly permissive. It allows all ICMP and HTTP traffic, and even allows vulnerabilities to be discovered via NMap.

Task III

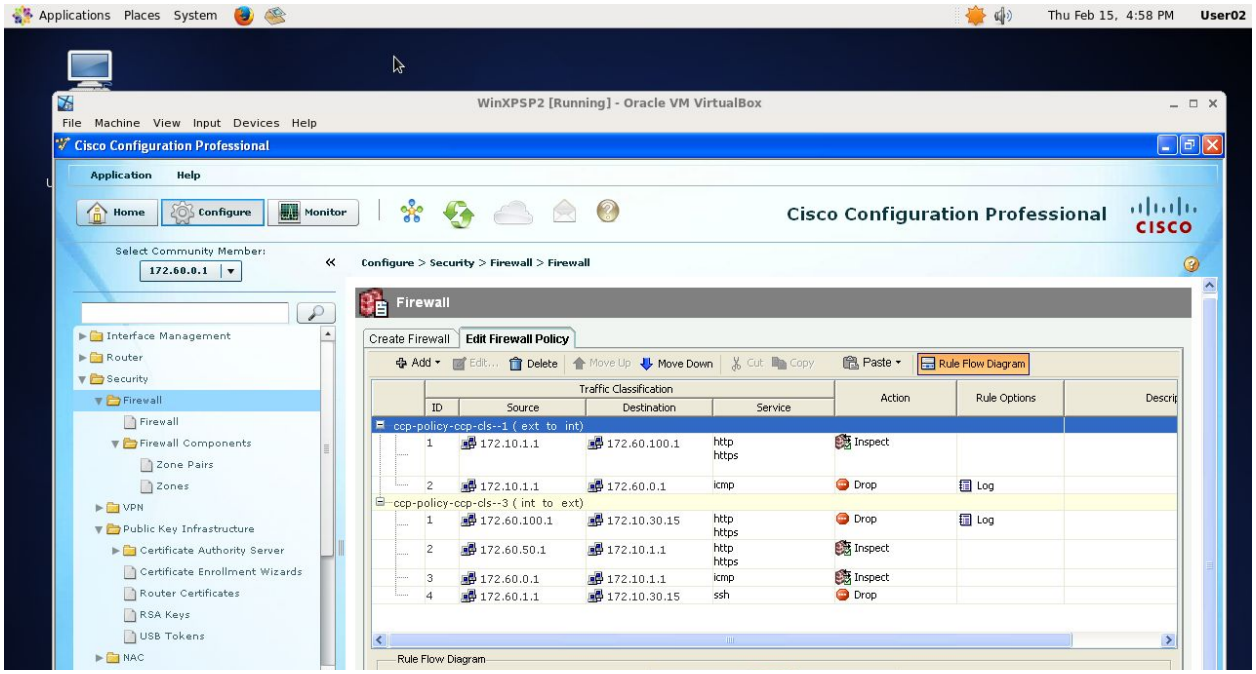
The third task in this project involved the creation and implementation of a new security policy. The policy created specifies that external computers should not be allowed to ping any computers on the internal (F) network, internal computers should be allowed to ping any computer, internal servers should allow internal and external access to their HTTP servers, internal servers should allow only internal access to SSH services, internal servers should not be allowed to access

external web servers, and internal computers should not be allowed to access any external SSH service. The internal workstations should be able to access external HTTP servers. That results in the Access Control Matrix below:

	Internal Workstation (F.1)	**Internal Server (F.2)**	**External Computer (A.F)**
F.1	**Owns +Ping**	**+HTTP +Ping +SSH**	**+HTTP +Ping**
F.2	**+Ping**	**Own +HTTP +Ping**	**+Ping**
A.F		**HTTP**	**Own +HTTP +Ping**

Matrix of Allowed Actions Between Group F Computers

Not all of the requested policies are possible to implement via the Cisco Firewall, however, as the firewall only checks traffic passing between zones. Traffic between F.1 and F.2, which are on the same interface on the router and thus the same zone, is not able to be secured by the router. Additionally, this traffic never reaches the router as it is directed by the intermediary switch. Because of this, rule of the policy, "Internal servers provide only SSH and web service to internal workstations" cannot be implemented at the router level. Additionally, rule D, "Internal workstations shall not provide any service" can only be partially implemented.



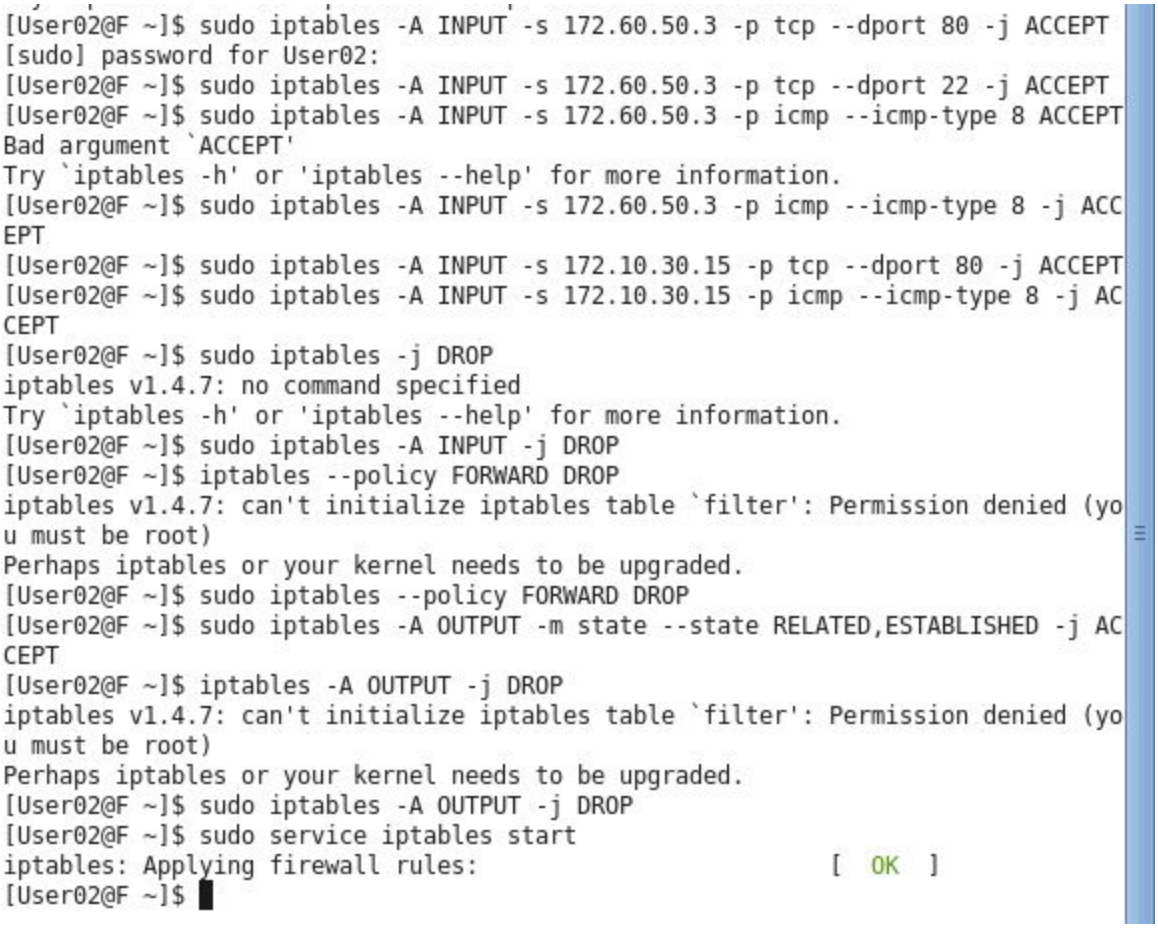
CISCO Firewall Policies Between Internal and External Computers

Of note, while the Firewall Configuration does not reflect it, Casey added an additional rule via Telnet into the router to block all non-matching traffic (access-list 101 deny ip any any).

Because the router-level firewall cannot enforce internal network rules, we need specific policy implementation on each internal computer. For the policy "Internal workstations shall not provide any service" we can simply write an IPtable rule "IPTABLES -A OUTPUT -j DROP" meaning all outgoing signals are blocked from leaving the machine. In the case of the internal server we want to block most traffic but allow specific request. We can achieve this by ordering our IPtables to place specific allowances before a general block.

Our server's IPtable input chain should consist of commands to allow SSH, HTTP and Ping from the internal workstation, as well as HTTP and ping from the external computer, before blocking all other inputs. However, we cannot use a general block for the output chain without limiting the servers ability to respond to request. Instead, we can use a pattern argument to allow all traffic with the ESTABLISHED state to go out from the machine. In practice, this means that only the allowed input

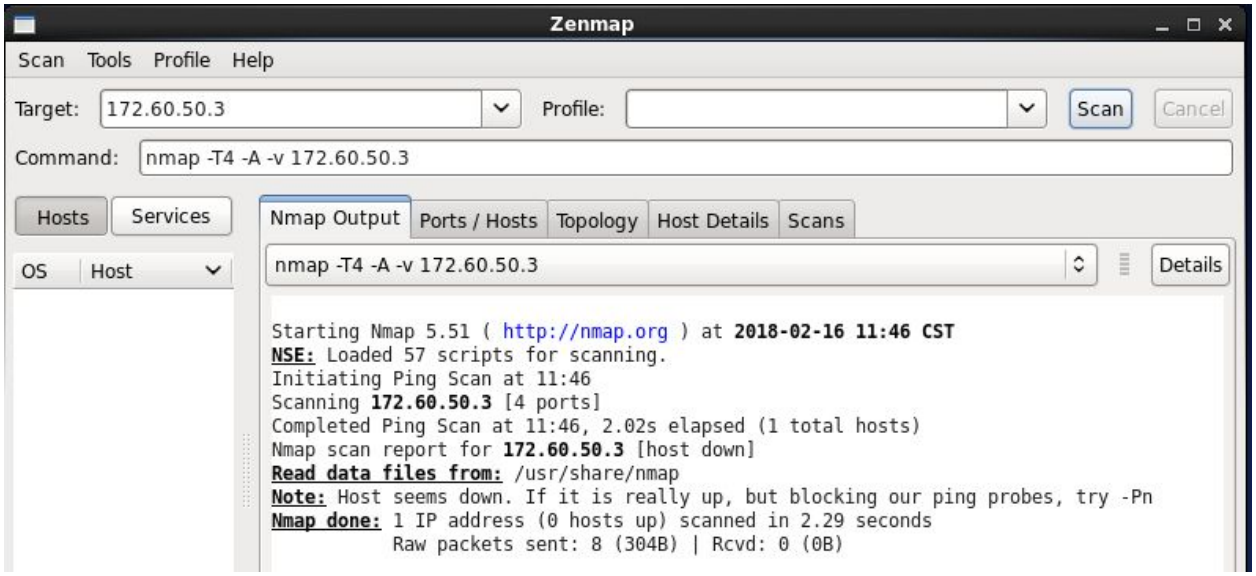
services will be able to establish a connection with our server and receive traffic in response.



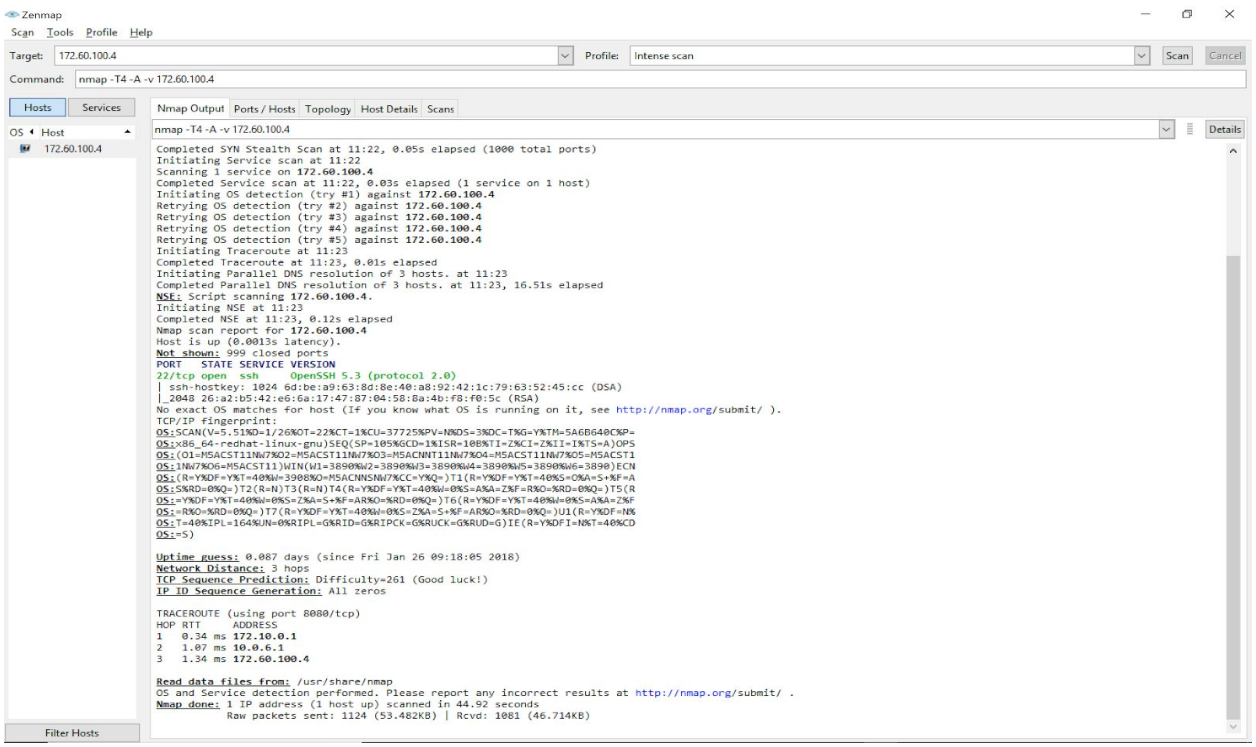
Programming the Internal Server IPtable

Task IV

In order to test the firewall configuration completely, we disabled the iptables firewall on all workstations and servers. The policy was then tested by performing an additional NMap against the internal (F.1, F.2) network. The results of this test are shown below.



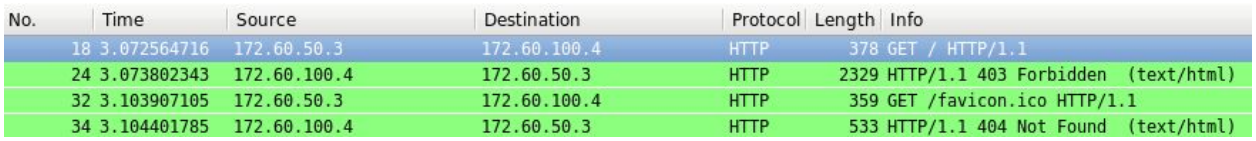
A.F to F.1 NMap: Blocked



A.F to F.2 NMap: Blocked

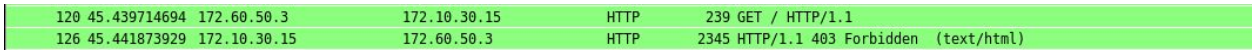
Web service availability was tested using curl -X GET from the command line of each computer. Packet captures from each

mapping of computer to computer are shown below. These show that F.1 is able to access the web service on F.2 and A.F, and A.F can access the web server on F.2, but no other combinations are allowed.



No.	Time	Source	Destination	Protocol	Length	Info
18	3.072564716	172.60.50.3	172.60.100.4	HTTP	378	GET / HTTP/1.1
24	3.073802343	172.60.100.4	172.60.50.3	HTTP	2329	HTTP/1.1 403 Forbidden (text/html)
32	3.103907105	172.60.50.3	172.60.100.4	HTTP	359	GET /favicon.ico HTTP/1.1
34	3.104401785	172.60.100.4	172.60.50.3	HTTP	533	HTTP/1.1 404 Not Found (text/html)

F.1 to F.2 Web Server Test (Success)

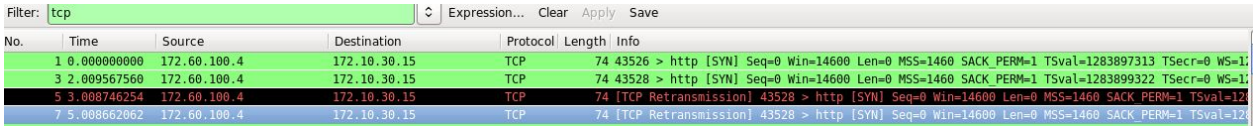


120	45.439714694	172.60.50.3	172.10.30.15	HTTP	239 GET / HTTP/1.1
126	45.441873929	172.10.30.15	172.60.50.3	HTTP	2345 HTTP/1.1 403 Forbidden (text/html)

F.1 to A.F Web Server Test (Success)

No.	Time	Source	Destination	Protocol	Length	Info
15	2.043827847	172.60.100.4	172.60.50.3	TCP	74	36890 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460
16	2.043966912	172.60.50.3	172.60.100.4	TCP	60	http > 36890 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0

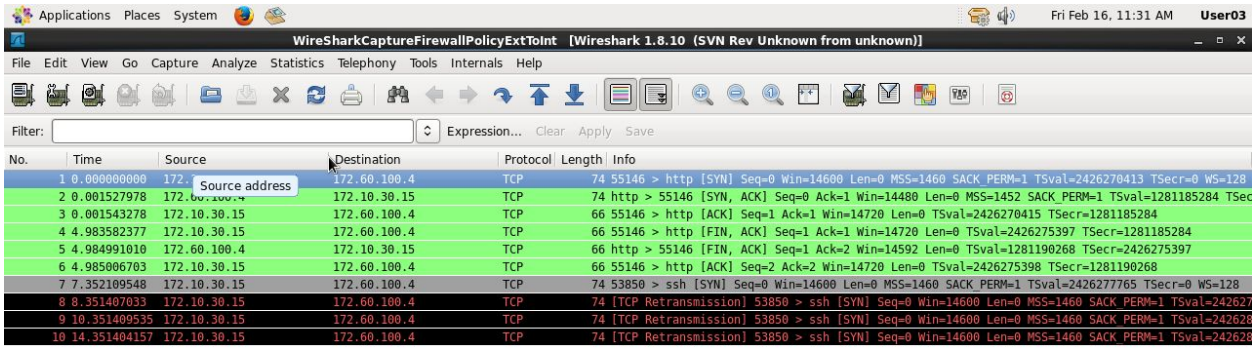
F.2 to F.1 Web Server Test (Fail)



Filter: tcp — Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.60.100.4	172.10.30.15	TCP	74	43526 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=1283897313 TSecr=0 WS=1
3	2.009567560	172.60.100.4	172.10.30.15	TCP	74	43528 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=1283899322 TSecr=0 WS=1
5	3.008746254	172.60.100.4	172.10.30.15	TCP	74	[TCP Retransmission] 43528 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=128
7	5.008662062	172.60.100.4	172.10.30.15	TCP	74	[TCP Retransmission] 43528 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=128

F.2 to A.F Web Server Test (Fail)



Applications Places System — Fri Feb 16, 11:31 AM — User03

WireSharkCaptureFirewallPolicyExtToInt [Wireshark 1.8.10 (SVN Rev Unknown from unknown)]

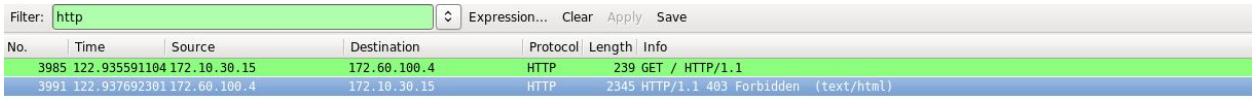
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: — Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172..	172.60.100.4	TCP	74	55146 > http [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=2426270413 TSecr=0 WS=128
2	0.001527978	172.60.100.4	172.10.30.15	TCP	74	http > 55146 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1452 SACK_PERM=1 TSval=1281185284 TSec
3	0.001543278	172.10.30.15	172.60.100.4	TCP	66	55146 > http [ACK] Seq=1 Ack=1 Win=14720 Len=0 TSval=2426270415 TSecr=1281185284
4	4.983582377	172.10.30.15	172.60.100.4	TCP	66	55146 > http [FIN, ACK] Seq=1 Ack=1 Win=14720 Len=0 TSval=2426275397 TSecr=1281185284
5	4.984991010	172.60.100.4	172.10.30.15	TCP	66	http > 55146 [FIN, ACK] Seq=1 Ack=2 Win=14592 Len=0 TSval=1281190268 TSecr=2426275397
6	4.985006703	172.10.30.15	172.60.100.4	TCP	66	55146 > http [ACK] Seq=2 Ack=2 Win=14720 Len=0 TSval=2426275398 TSecr=1281190268
7	7.352109548	172.10.30.15	172.60.100.4	TCP	74	53850 > ssh [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=2426277765 TSecr=0 WS=128
8	8.351407033	172.10.30.15	172.60.100.4	TCP	74	[TCP Retransmission] 53850 > ssh [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=242627
9	10.351409535	172.10.30.15	172.60.100.4	TCP	74	[TCP Retransmission] 53850 > ssh [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=242628
10	14.351404157	172.10.30.15	172.60.100.4	TCP	74	[TCP Retransmission] 53850 > ssh [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=242628

Source address

A.F to F.1 Web Server Test (Fail)

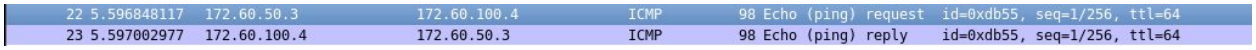


Filter: http — Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
3985	122.935591104	172.10.30.15	172.60.100.4	HTTP	239	GET / HTTP/1.1
3991	122.937692301	172.60.100.4	172.10.30.15	HTTP	2345	HTTP/1.1 403 Forbidden (text/html)

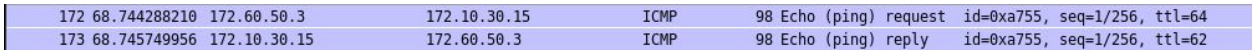
A.F to F.2 Web Server Test (Success)

The security policy stated earlier disallows the external computers to ping the internal computers, but the internal computers should be allowed to ping all computers. The screenshots below show the successful and unsuccessful pings across the network



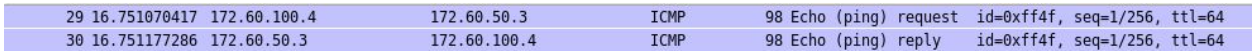
22 5.596848117	172.60.50.3	172.60.100.4	ICMP	98 Echo (ping) request	id=0xdb55, seq=1/256, ttl=64
23 5.597002977	172.60.100.4	172.60.50.3	ICMP	98 Echo (ping) reply	id=0xdb55, seq=1/256, ttl=64

F.1 to F.2 Ping Test (Successful, shows Reply)



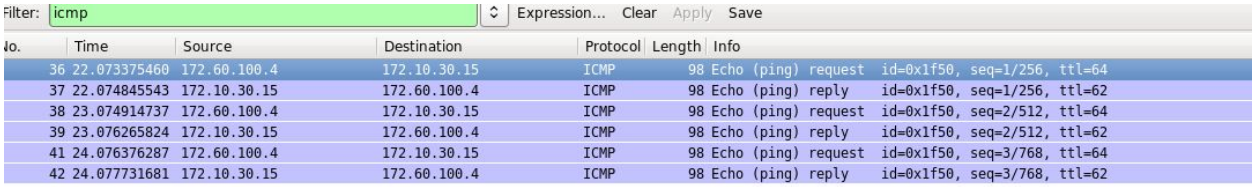
172 68.744288210	172.60.50.3	172.10.30.15	ICMP	98 Echo (ping) request	id=0xa755, seq=1/256, ttl=64
173 68.745749956	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) reply	id=0xa755, seq=1/256, ttl=62

F.1 to F.2 Ping Test (Successful, shows Reply)



29 16.751070417	172.60.100.4	172.60.50.3	ICMP	98 Echo (ping) request	id=0xff4f, seq=1/256, ttl=64
30 16.751177286	172.60.50.3	172.60.100.4	ICMP	98 Echo (ping) reply	id=0xff4f, seq=1/256, ttl=64

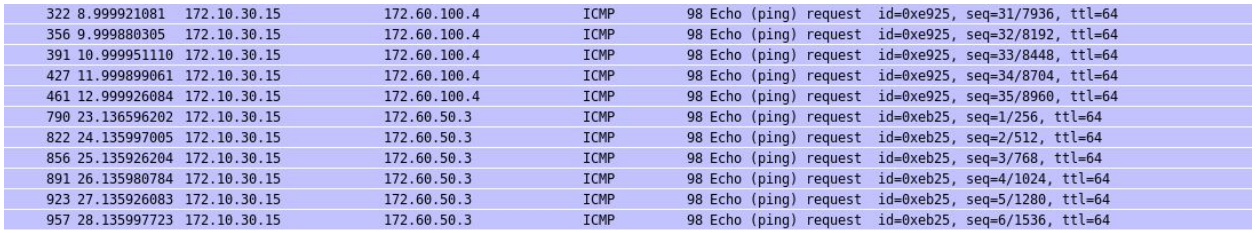
F.1 to F.2 Ping Test (Successful, shows Reply)



Filter: icmp — Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
36	22.073375460	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) request id=0x1f50, seq=1/256, ttl=64
37	22.074845543	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) reply id=0x1f50, seq=1/256, ttl=62
38	23.074914737	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) request id=0x1f50, seq=2/512, ttl=64
39	23.076265824	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) reply id=0x1f50, seq=2/512, ttl=62
41	24.076376287	172.60.100.4	172.10.30.15	ICMP	98	Echo (ping) request id=0x1f50, seq=3/768, ttl=64
42	24.077731681	172.10.30.15	172.60.100.4	ICMP	98	Echo (ping) reply id=0x1f50, seq=3/768, ttl=62

F.1 to F.2 Ping Test (Successful, shows Reply)



322 8.999921081	172.10.30.15	172.60.100.4	ICMP	98 Echo (ping) request	id=0xe925, seq=31/7936, ttl=64
356 9.999880305	172.10.30.15	172.60.100.4	ICMP	98 Echo (ping) request	id=0xe925, seq=32/8192, ttl=64
391 10.999951110	172.10.30.15	172.60.100.4	ICMP	98 Echo (ping) request	id=0xe925, seq=33/8448, ttl=64
427 11.999899061	172.10.30.15	172.60.100.4	ICMP	98 Echo (ping) request	id=0xe925, seq=34/8704, ttl=64
461 12.999926084	172.10.30.15	172.60.100.4	ICMP	98 Echo (ping) request	id=0xe925, seq=35/8960, ttl=64
790 23.136596202	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=1/256, ttl=64
822 24.135997005	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=2/512, ttl=64
856 25.135926204	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=3/768, ttl=64
891 26.135980784	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=4/1024, ttl=64
923 27.135926083	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=5/1280, ttl=64
957 28.135997723	172.10.30.15	172.60.50.3	ICMP	98 Echo (ping) request	id=0xeb25, seq=6/1536, ttl=64

A.F to F.1 and F.2 Ping Test (Failure, no Reply received)

Despite our attempts to secure the confidential information stored on computer F.1, including barring the use of flash drives, it is still wholly possible to exfiltrate confidential information from the company's network, given certain conditions. As server F.2 hosts a web server of unknown security measures, it may be possible to POST arbitrary information to the web server via CURL or web server. This information may then be extracted by the same person or by an especially clever

outsider, could retrieve that information by similar method. This issue can only be resolved through clever configuration of deep packet inspection, firewall, iptables, and/or web server configuration to disallow the types and content of connections so proposed. There may exist other vulnerabilities to the network not determined at this time.